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# Extending the Endurance and Capabilities of the Raven/Puma UAVs using Advanced Flexible Solar Cells

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## Research Project Background

Unmanned systems have become increasingly popular among each of the military services. SUAS allows the rapid and relatively safe employment of ISR assets to provide information to unit leaders. The need for increased flight duration SUAS is present in a wide range of mission sets. With extended flight endurance, ground forces can reduce the weight of batteries carried. Another added benefit is that we can reduce coverage gaps in surveillance by reducing the amount of battery replacement cycles when monitoring a target set.

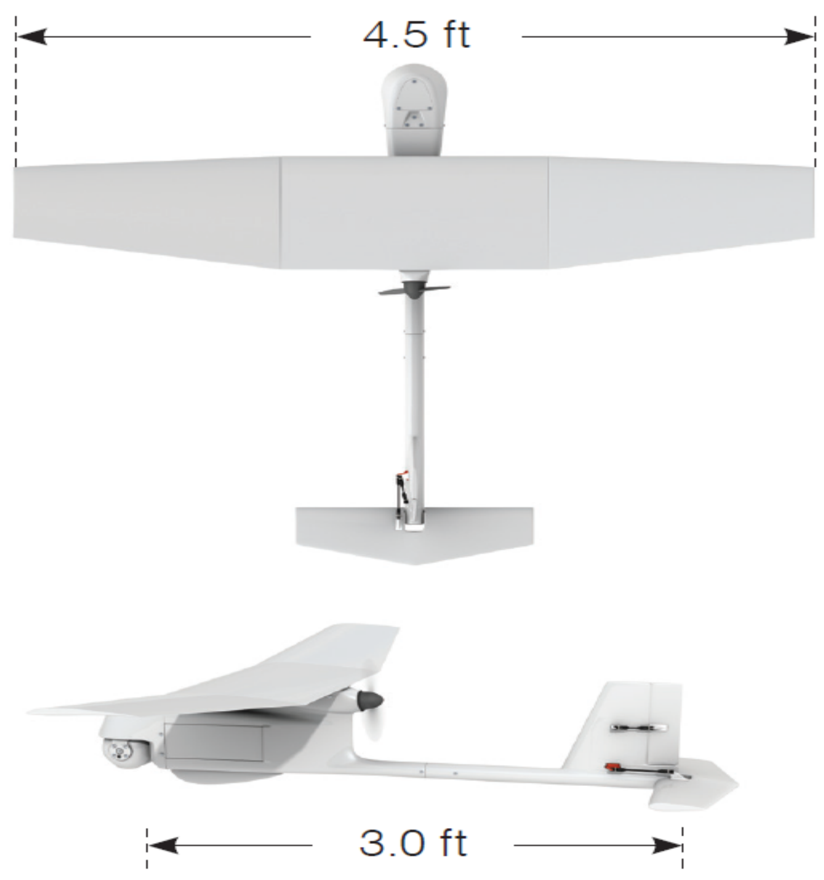


Fig. 1. The RQ-11B Raven

## Research Process

- The goal of this research was to determine the feasibility of integrating low-cost flexible PV cells to augment the internal battery supply of a UAV in order to increase the flight duration.
- One major contribution in this research was determining baseline power consumption during typical missions. Using the Raven RQ-11B of Fig.1, as the testing platform.
- With certified Raven operators, we were able to conduct field-testing of the Raven performance metrics under different environmental conditions experienced by operating forces.
- Analyzing the throttle percentage and overall current draw, as depicted in Fig.2, we were successfully able to determine that the Raven typically consumed an average of 50 W of power.
- Investigation of available solar cells to be utilized on the Raven wing was conducted to maximize the photovoltaic power generated by the limited wing area. The low cost Sunpower IBC silicon solar cells were selected due to their high conversion efficiency of about 22% compared to the 12% cells utilized in the previous research. This resulted in a sizable increase in produced power. See Fig. 3 for comparison of the two cells.
- The solar wing design utilizing the IBC PV cells was able to generate 34 W of power at its maximum power point as shown in Fig. 4.a. The solar wing was then integrated with the Raven vehicle through a Maximum Power Tracking circuit [MPPT] and a dc/dc converter to further maximize the power output under different sun conditions as illustrated in Fig 4.b.
- The solar powered wing was then connected to the Raven UAV during static flight simulations, Fig 5.a, to experimentally measure its extended endurance. Overall, we were able to increase the flight duration by 125.6%, which is more than doubling the original capability as demonstrated in Fig 5.b.

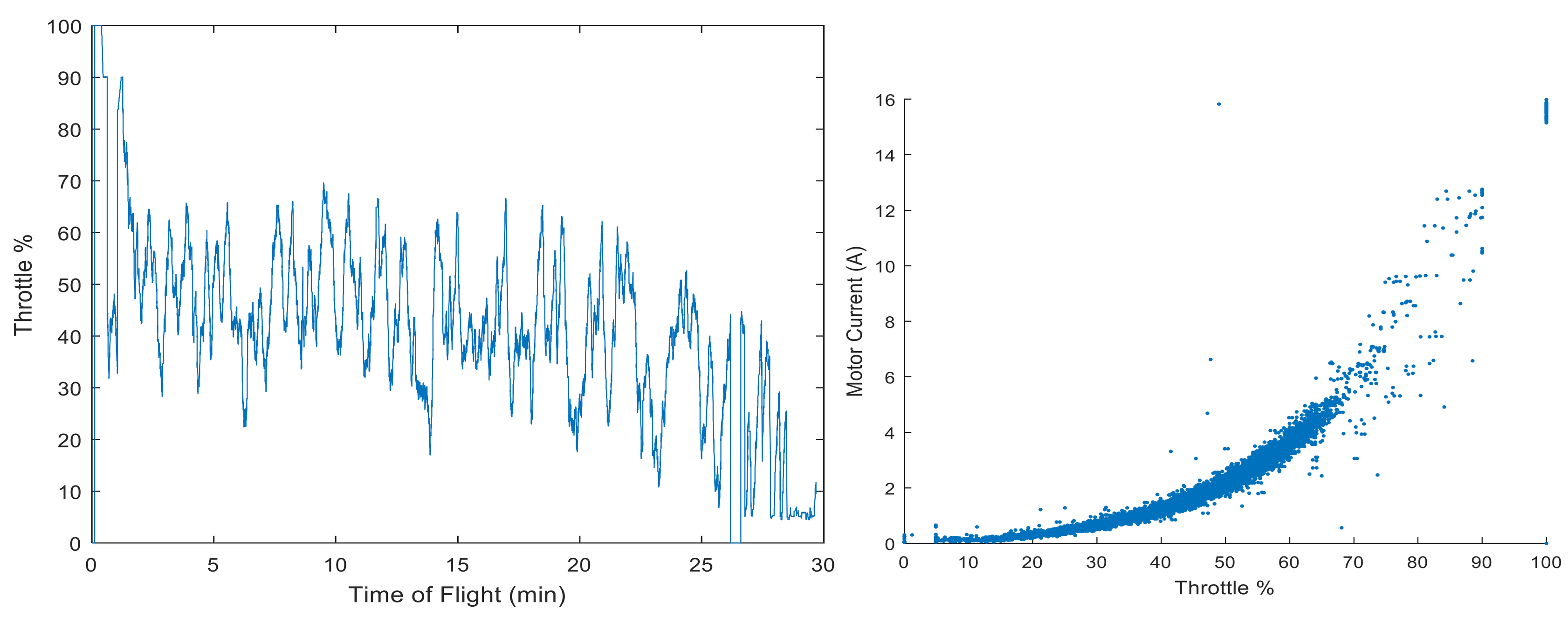


Fig. 2. Typical RQ-11B Raven throttle percentage/current relationship.

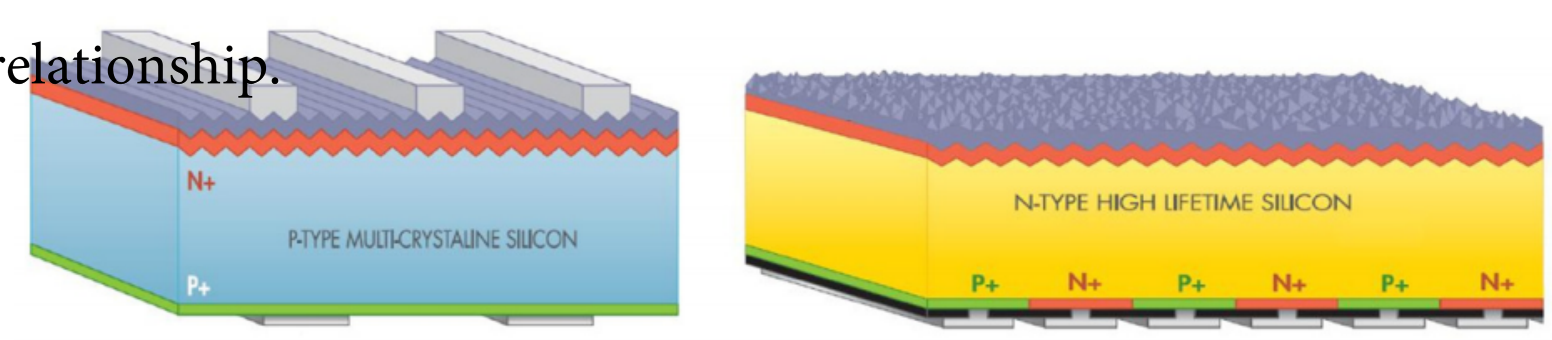


Fig. 3. Conventional cell design (left) and IBC cell (right), used in project.

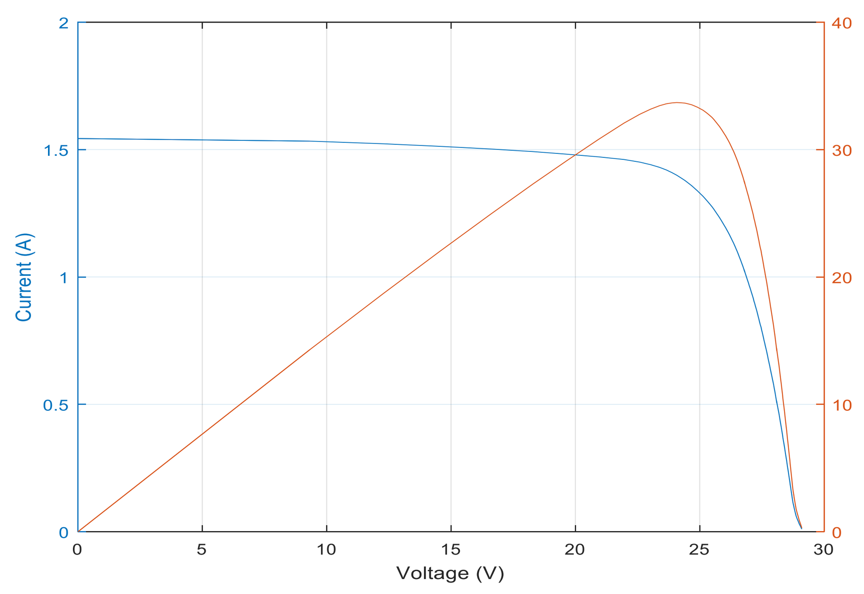


Fig. 4.a. I-V and power curve of PV Array.

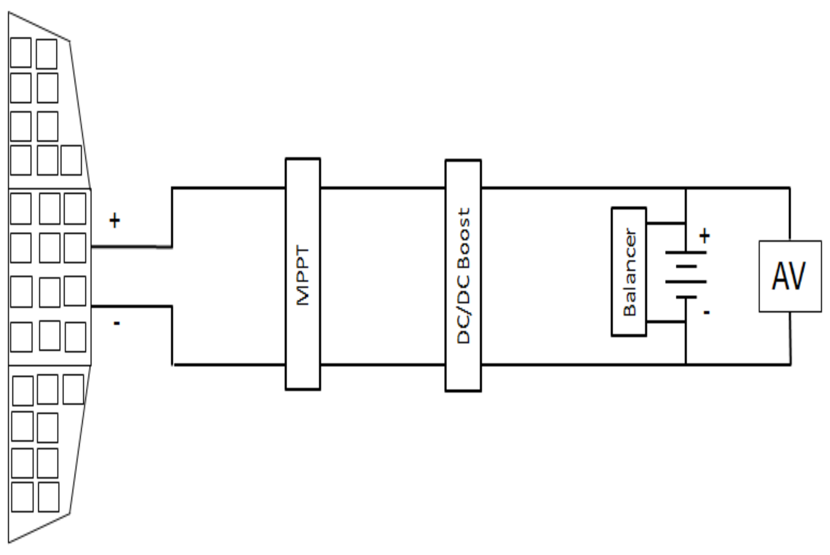


Fig. 4.b. Solar/AV integration

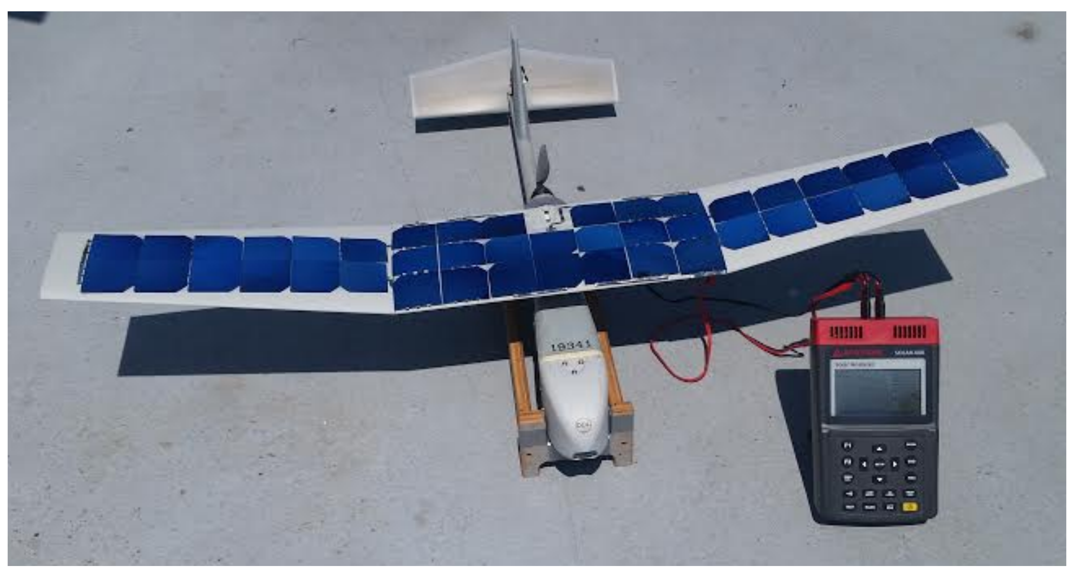

Fig. 5.a. Testing of the solar Raven UAS.

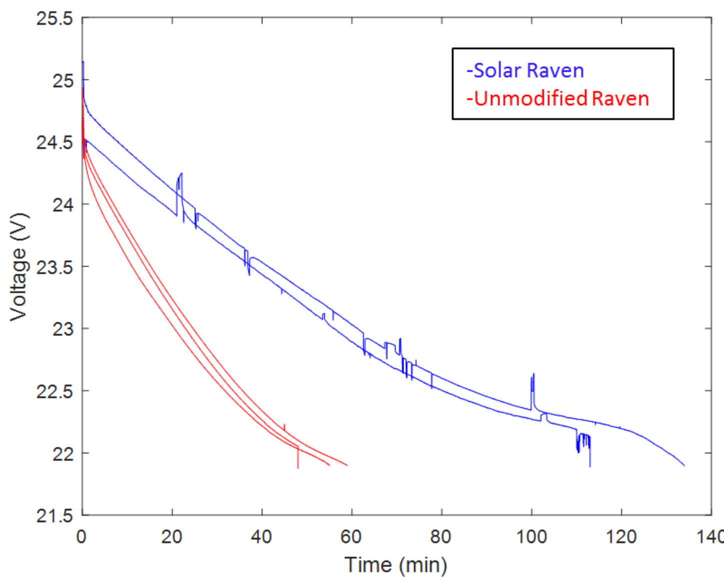


Fig. 5.b. Extended endurance flight duration comparison.

## Findings and Conclusions

In conclusion, research objectives were met and the feasibility of augmenting the battery powered UAV by integrating IBC PV cells was confirmed. The solar powered Raven wing designed and tested in this research was found to experimentally increase the simulated flight time of a conventional Raven UAV by more than 2 ½ times of its regular mission endurance. Finally, the increased capability was gained with a minimal additional cost incurred.

Fig. 6. The RQ-20A PUMA for consideration in future Solar UAS project.

## Recommendations for Further Research

**Extending the Endurance of other Group 1 Air Vehicles:** The RQ-20A, Puma UAV depicted in Fig. 6, has nearly double the wing surface area which makes a very viable candid for further extend its flight time beyond the successful findings of this research.

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